III. *On the Position of the North Magnetic Pole. By Commander* James Clark Ross, *R.N. F.R.S. F.R.A.S. F.L.S. &c.*

Received December 19,—Read December 19, 1833.

THE determination of the position of the Magnetic Poles of the earth has ever been considered a desideratum in the science of magnetism, of the highest importance; and the observations and experiments of the most ingenious and learned philosophers have universally been applied to the solution of this difficult and perplexing problem. Vague and unsatisfactory, however, were the results of the researches and calculations of the most indefatigable and zealous promoters of that science, arising, doubtless, in a great measure, from the discordant observations upon which they were founded,—a discordance which was considered to arise chiefly from the unequal distribution of the magnetic substances contained in the earth, and also from the great distances at which the observations were made from the centres of the powers of those magnetic substances, or, in other words, from the magnetic foci, or poles, of the earth.

The primary cause of magnetic phenomena has always been, and still is, one of the secrets of nature, although several of the laws of magnetism have of late years been gradually developed: and during our absence from England, a greater step perhaps than any former one has been made, through the indefatigable research of Dr. Faraday, by his splendid and convincing proofs of its complete identity with electricity. Still much remains to be accomplished relative to terrestrial magnetism; and accurate observations with good instruments, as near the magnetic poles as possible, and in various directions from them, were long considered amongst the desiderata for completing the magnetic theory of the globe.

These wants, as far as relates to the northern magnetic regions, have been supplied by the expeditions by land and sea that have been sent from England for the discovery of a north-west passage, to traverse the shores of the American continent, and to contribute to the advancement of science in general. In the department of magnetism, in particular, the numerous and accurate observations by their distinguished commanders, and those who accompanied them, have been eminently important. Those made to the north-west of the magnetic pole by Captain Sabine, to the south-west by Captain Franklin, and to the south-east and north-east by Captain Parry, Mr. Fisher, and Captain Forster, have furnished materials that have enabled the British philosophers to point, with a wonderful degree of precision, to the seat of magnetic concentricity.

In contemplating the equipment of the late expedition, a still nearer approach than had yet been attained to that mysterious spot was anticipated from the route that we purposed to pursue; but the smallness of the vessel in which we embarked necessarily limited the number and magnitude of our magnetic instruments. A small dipping-needle by JONES, belonging to the Admiralty, was, together with a number of other instruments, liberally offered for our use; and having been made with much care by that celebrated artist for the use of the party that travelled towards the north pole under Captain PARRY, and been found on that occasion to answer every purpose for which it was intended, we did not hesitate to consider it sufficiently large and accurate for this service. A description of the instrument accompanies the Table of Observations made by Captain PARRY and Lieutenant FORSTER in the Appendix to the Narrative of that Voyage (p. 168), and renders any further remarks here unnecessary. It is, however, to be regretted, that prior to our departure from England we had no opportunity of making any observations with that instrument; and a defect in the vertical circle, which was not detected till the spring of the year 1831, has rendered it necessary to reject all the observations on the intensity of the magnetic force made previous to that period.

The annexed Table contains most of the observations that were obtained on the dip of the magnetic needle during our late voyage in the Victory, and seems to require but little explanation. I have considered it proper to record the mean of the readings of each end of the needle in each of its eight positions, because, in looking over the Table, it will be seen that scarcely any two results show any very near accordance, and, in some instances, their differences amount to several degrees. Whether this arises from any imperfection in the instrument, from the method of magnetizing it, or from a variation in the direction of the poles of the needle, I am unable to determine. As the several readings presented themselves, so they were registered; and the resultant dips, although in some instances they show a very considerable difference, yet, upon the whole, their accordance affords a remarkable instance of the tendency of errors (if such they be) to correct each other. Be that as it may, it is proper that these discordances should be known, in order that their cause may be investigated, and that the observations should not obtain a greater degree of dependence than, on examination, they may be found to deserve. Each of the recorded observations is the mean of six to ten readings of each end of the needle in its several positions, and the method employed in the reversion of its poles is that of DU HAMEL.

Only three opportunities occurred of observing the dip as we proceeded to the southward of Fury Point to our first winter quarters. But these, together with the variation, &c., were important assistants in calling our attention to the rapid approach we were making towards the magnetic pole. A series of observations during the winter led us to expect that that point would be found directly to the westward of us; but we were unconscious at that time of the existence of an ocean in that direction, and the calculated distance far exceeded anything we could hope to travel over a country

whose rugged shores seemed to forbid the attempt, and to annihilate every hope of its accomplishment. The discovery of the Western Ocean, however, across a narrow neck of land to the south-west, which occurred early the following spring, gave rise to a small party being sent from the ship, to endeavour to trace the shores of the American continent as far to the south-west or west as possible. On that occasion, owing to the smallness of the party, it was found impracticable to carry more instruments than were actually indispensable for determining the outline of the coast along which we might pass. An azimuth compass, of Captain KATER's construction, was the only magnetic instrument that could be taken, and this was, soon after leaving the ship, destroyed by a fall over a precipice at Cape Isabella, soon after I had determined that its north point was directed to the north-west. Its action was uncertain to eight or ten degrees, owing to the extreme weakness of the directive force of the needle.

Imperfect as this indication was, it seemed to cherish the hope of our being able to obtain some interesting magnetic observations; when having been compelled to pass another winter near the same spot, I proposed to conduct a party, guided by some Esquimaux, across the country to the westward, and to endeavour to approach as near as possible to the source of magnetism. We accordingly commenced our journey in the middle of May 1831: but the unfavourable nature of the season prevented my obtaining any observations that could be of assistance to us until we reached the shores of the Western Ocean on the 28th of the month. Here good observations were made under the most favourable circumstances; and the magnetic dip having now increased to 89° 41′, and the horizontal needle pointing to N. 57° W., led us to expect that, at the distance of about thirty-five miles in that direction, we should attain the object of our wishes. That spot being now well within our reach, I did not hesitate to devote the larger part of the day to repeating those observations, anticipating that, after leaving that spot, little assistance could be expected from the horizontal needle in directing our approach to the magnetic pole. Having gained the calculated position on the 1st of June, without having been able, from the unfavourable state of the weather, during that interval, to obtain any more observations, I availed myself of the snow huts of a recently deserted Esquimaux village as observatories, and encamped the party at a sufficient distance to ensure their being beyond the possibility of producing any influence on the needles, &c.

My attention was first of all directed to ascertain, if possible, the direction of the magnetic meridian. For this purpose I suspended horizontally the needle that was used only for the determination of the intensity of the magnetic force, first by three or four delicate fibres of floss silk. It remained, however, exactly in the position in which it was placed. A single fibre of the floss silk was next tried, and lastly a single fibre of flax. All these failing to demonstrate the smallest amount of horizontal attraction, a second needle was treated in a similar manner, and in all these attempts I was equally unsuccessful. The top of the instrument being so constructed as to admit of a half-circle of torsion, this was next tried; but the needle was moved from

its position in nearly the same amount as the arc described by the point of suspension, showing that the smallest amount of torsion was sufficient to overcome the directive energy of the needle.

The needle was now removed to the dipping apparatus, and the following observations on the intensity of the vertical force of the needle were obtained, upon the supposition, that in whatever direction a given number of vibrations in the same arc were made in the shortest time, that might be assumed as the magnetic meridian. The direction of the needle is given in true bearings.

S. 50° W. and N. 50° E.	S. 80° W. and N. 80° E.	N. 70° W. and N. 70° E.	N. 40° W. and S. 40° E.	N. 10° W. and S. 10° E.	N. 20° W. and S. 20° W.
h m s	h m s	h m s	h m s	h m s	h m s
10 34 20	10 37 28·7	10 40 50·2	10 44 3	10 46 59·5	10 49 47·5
43	52·5	41 13·5	26·5	47 23	50 10·5
35 5·2	38 14·5	36·5	49·2	45·5	33·2
27	36·2	57·5	45 10·5	48 7·5	54·7
48·5	58	42 19	32·5	29	51 16·2
36 10·2	39 18·7	40·7	54	50·7	37·5
50 Vibns in 1 50·2	1 50	1 50·5	1 51	1 51·2	1 50

From these observations it was equally impossible to assign a direction to the magnetic meridian, the slight differences being within the limits of the errors of observation, and the amount of the inclination or dip of the needle in each of these directions being precisely the same. A diminution of force, however, may seem to obtain in the directions of S. 10° E. and S. 40° E.; and a direction at right angles to that, S. 75° W., I assumed as the magnetic meridian in the first two sets of dip. The mean of these was 89° 58′ 15″. The next two sets were taken at an angle of 45° to the right of the former, and their mean result was 89° 59′ 46″; and the two last sets, exactly at right angles to the first set, gave the dip 89° 59′. In these last observations the axis of the intensity needle was put in the stead of its own axis, which accounts for the difference in the readings of the needle in its several positions, as will be seen by the table of dips. The reason for my doing this was to provide against the possibility of the observations being influenced by an injury which the axis of the needle was supposed to have sustained, by the great difference that sometimes occurred in its indications. The result of these observations, however, shows that the injury, if it had met with any, did not materially affect the results; so perfectly do the principles of its construction counteract any slight bend in the axis, or any inequality in the balance of the needle.

To complete the observations on the intensity of the magnetic force, and the various experiments which were made, and which it is unnecessary here to notice, occupied the whole of the time that I could devote to that purpose. And although there is a difference, amounting to several minutes, in the different observations made in the same direction of the needle, yet the resultant mean dip in each of the three directions

in which they were obtained placed us as near to the magnetic pole as, with our limited means, we were able to determine. And although it cannot but be a rough approximation, yet it is hardly possible to be more than a few miles from the exact position. It was, at any rate, quite impossible for us to know, now that the horizontal needle had ceased to act, in what direction to proceed for the purpose of approaching it more nearly; for, in order to determine its exact position, the cooperation of several observers, placed at some distance, in various directions of its position, would be necessary. A series of observations, continued for some months, would afford the most important and interesting data. By such means, not only its actual position, but its diurnal, if not its annual motions, could be determined, and furnish the means of investigating most of the phenomena of magnetism which are now exhibited on our globe; and establishing for future ages a most important point of reference, by which any progressive movement may be ascertained, and ultimately brought within the reach of mathematical determination for any given period.

This is precisely what is still wanting; and now that its position is so nearly known, and that it is placed in a spot easy of access, and affording every facility for carrying such a series of operations into effect, it only remains to be considered whether those who have the power to promote such an undertaking may attach sufficient importance to the subject to direct its being carried into execution. It is certainly every way worthy of our country. The science of magnetism, indeed, is eminently British. There is no other country in the world whose interests are so deeply connected with it as a maritime nation, or whose glory as such is so intimately associated with it, as Great Britain. All the late discoveries and improvements are to be attributed to the perseverance of British science, and the encouragement and assistance of an enlightened and liberal Administration. Nor will the name of Felix Booth, Esq. be omitted in the list of our country's most distinguished patriots, whose munificence and princely spirit have furnished the whole pecuniary means of obtaining the results which are now presented to the Society; and, I may fearlessly venture to add, of enabling a few British seamen to plant the flag of their country upon the Northern Magnetic Pole of the earth.

Observations on the Dip of the Magnetic Needle.

Date.	Time of the day.	Poles of the Needle direct.					Poles of the Needle reversed.					Observed Dip.	Remarks.
		Axis direct.		Axis reversed.		Mean.	Axis direct.		Axis reversed.		Mean.		
		Face East.	Face West.	Face West.	Face East.		Face East.	Face West.	Face West.	Face East.			
1831.		° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	
Feb. 15.	Noon.	78 11·5	99 34·73	78 6·23	99 25·67	88 49·53	79 26·17	98 37·67	79 17·33	98 52·5	89 3·42	88 56·47	
28.	1 P.M.	81 30	98 38·78	79 35·60	98 14·50	89 29·72	72 7·86	103 38·44	72 52	105 43·75	88 35·51	89 2·61	
March 1.	2 P.M.	81 42·8	97 52	81 7	96 49·4	89 22·80	77 16	100 27	77 47·42	98 49·6	88 35·0	88 58·90	
4.	Noon.	81 34·8	96 37·4	81 18	97 25	89 13·8	76 30·4	101 10	78 15·6	99 27	88 51·25	89 2·52	
15.	1 P.M.	81 34·7	96 34·5	81 34·2	96 41·2	89 6·15	75 27·5	102 12·3	75 6·9	102 59·5	88 56·55	89 1·35	
21.	4 P.M.	75 5·67	103 6·17	74 12·83	101 8·33	88 23·14	81 14·5	97 6	81 56·1	95 35·3	88 57·97	88 40·56	Mean observed dip at Sheriff's Bay in lat. 70° 1′ N., and long. 91° 54′ W. Variation 96° 12′·3 W. previous to my journey towards the magnetic pole = 88° 57′·04 N. (1831.)
22.	4 P.M.	86 7·63	91 30·17	87 0·0	90 29	88 47·7	86 13	92 35·7	87 19·83	90 37·83	89 11·59	88 59·15	
23.	3 P.M.	86 18·2	91 11·35	87 9·14	90 47	88 51·42	86 24·17	90 17	87 28	91 22	88 47·29	88 49·36	
24.	2 P.M.	81 56·5	96 18·7	81 49·7	96 0·20	89 1·27	81 57·70	95 40·1	81 18	97 20·2	89 4·0	89 2·64	
25.	3 P.M.	78 56	98 30	78 1·1	99 27·5	88 43·65	79 51·4	99 12·17	80 8·72	97 21·4	89 8·42	88 56·04	
30.	3 P.M.	77 41	99 49·25	77 38·75	99 44·44	88 43·36	81 23·9	96 58·3	81 59·4	96 26·4	89 12·0	88 57·68	
April 1.	2 P.M.	76 47·1	100 2·90	78 29	100 14·20	88 53·27	81 52·4	95 48·14	81 27·12	97 13·4	89 5·27	88 59·27	
	4 P.M.	78 40·67	99 2·17	78 36·33	98 52	88 48·04	80 8·27	97 51·13	80 20·27	97 48·5	89 2·04	88 55·04	
May 28.	8 A.M.	86 31·7	92 47	86 26·83	93 30	89 48·87	73 9·5	106 11·5	84 20	94 35·8	89 34·2	89 41·53	89° 41′·9 N. Variation 57° 15′ W.; lat. 69° 34′ 45″ N.; long. 94° 53′ W.
	2 P.M.	86 17·22	92 51·3	87 2·14	93 32·16	89 55·71	74 42·2	104 58·22	83 24·7	94 50·18	89 28·83	89 42·27	
June 1.	Noon.	86 23·67	93 8·33	87 6·17	93 32·83	90 2·75	73 53·67	104 51·67	83 44·33	97 7·5	89 54·29	89 58·52	89° 58′·11 N. Assumed direction of meridian S. 75° W. (True.)
	3 P.M.	85 55·5	93 32·62	86 40·67	93 54	90 0·71	73 22	105 24·83	83 23·33	97 28·67	89 54·71	89 57·71	
	5 P.M.	86 32·33	93 10·33	87 16·67	93 9·83	90 1·79	74 58·83	104 16·83	83 0·83	97 5·13	89 50·15	89 55·97	89° 59′·465 N. Assumed direction of meridian N. 60° W.; lat. 70° 5′ 17″ N.; long. 96° 45′ 48″ W.
	7 P.M.	86 52·83	93 9·67	87 14·50	93 32·0	90 12·25	74 55	104 24·5	83 38·17	96 37	89 53·67	90 2·96	
2.	9 A.M.	84 24.33	96 12·67	82 46·37	96 55·1	90 4·62	82 29·5	97 14·33	85 14·5	94 58·33	89 59·14	90 1·88	89° 59′ N. Assumed direction of meridian N. 15° W.
	11 A.M.	84 3	96 25·56	82 32·60	96 35·75	89 54·08	82 36·5	97 26·75	85 20·67	94 29·0	89 58·17	89 56·12	
6.	8 A.M.	86 0·5	92 15·83	86 58·33	93 6·67	89 42·38	75 25·67	103 55·83	82 40·17	96 28·5	89 37·54	89 40·19	Same position as on the 28th of May.
8.	9 A.M.	86 27·5	92 3·33	87 13·67	92 17·83	89 30·58	75 20	101 36·17	81 22·33	98 37·83	89 14·04	89 22·33	At Cape Isabella. Lat. 69° 26′ 20″; long. 93° 51′ W.
9.	8 A.M.	84 42·83	94 33·13	84 25·67	93 42·5	89 21·03	77 48·83	100 1	81 42	97 21·5	89 13·33	89 17·18	At Padleak. Lat. 69° 30′ 1″; long. 93° 27′ 52″ W.
17.	2 P.M.	86 5	92 40·2	87 41·5	91 52·5	89 34·8	82 41	93 30	85 1·3	93 2·3	88 33·65	89 4·22	
	5 P.M.	86 9·8	91 48·5	87 45	91 15	89 14·57	80 45	96 30·8	85 9·2	93 7	88 53	89 3·79	
July 13.	2 P.M.	85 43·33	92 4·5	87 50·33	91 42	89 20·40	82 23	95 1·5	82 37	95 14·83	88 49·04	89 4·74	Observed dip at Sheriff Bay on my return from the magnetic pole 89° 3′·32 N. (1831.)
Aug. 12.	1 P.M.	86 27·5	91 41·7	87 57·5	91 14·7	89 20·35	84 9·2	93 24·2	79 45·8	97 38·3	88 44·37	89 2·36	
20.	Noon.	80 3·34	98 7·5	80 46·7	97 20·8	89 4·53	76 15·7	101 30	99 53·2	78 15	88 58·47	89 1·50	
Oct. 21.	10 A.M.	84 40·17	93 52	84 24	93 33·45	89 7·40	79 1·89	98 5·67	81 36·67	96 5	88 42·31	88 54·86	
22.	9 A.M.	84 40·5	94 16·5	84 50·12	93 49·37	89 24·12	77 29·4	99 41	80 24·5	96 45·2	88 35·03	88 59·57	
23.	Noon.	84 9	93 13·9	84 40·6	93 43·2	88 56·67	78 55·4	99 5·9	81 57·6	95 32·8	88 53·93	88 55·30	
Nov. 21.	Noon.	84 18·8	94 8·1	84 18·1	94 27·9	89 17·98	77 20·5	99 22	78 41·8	98 5·6	88 22·47	88 50·22	
22.	1 P.M.	84 56·2	93 46·6	84 54·6	93 48·6	89 21·5	78 55·3	98 24	79 28·3	96 51	88 24·65	88 53·07	
23.	1 P.M.	84 43	93 37·6	84 59	93 24·4	89 11	79 39·8	98 8	80 36·2	95 55·4	88 34·88	88 52·92	
Dec. 24.	10 A.M.	84 42·9	93 50·7	84 11·7	94 32·6	89 16·97	79 47·5	98 31	81 51·5	94 46	88 44	89 0·49	
	1 P.M.	85 21·5	93 2	84 19.8	93 57	89 10·07	79 58·6	98 16·8	81 37	94 41·5	88 38·48	88 54·27	Observed dip at Victory Harbour 88° 54′·86 N. Variation 101° 32′·03 W.; lat. 70° 9′ 18″ N.; long. 91° 30′ 33″ W.
1832.													
Jan. 21.	Noon.	85 1	94 8·6	84 24·5	94 23·2	89 29·32	76 53	100 16·2	81 7	95 59·4	88 33·9	89 1·61	
Feb. 16.	1 P.M.	84 58·5	95 11·8	83 17·3	95 14	89 40·04	76 46·1	100 52	79 51·7	96 31·1	88 30·22	89 5·31	
18.	1 P.M.	83 48·4	95 18·6	81 58·1	95 19·7	89 6·2	77 30·1	100 39·5	81 30·4	95 37·8	88 49·45	88 57·82	
March 17.	3 P.M.	83 16·2	94 41·6	82 32	95 42·1	89 2·98	74 53·9	102 45·2	78 55	96 3·1	88 9·3	88 36·14	
27.	2 P.M.	83 30·7	94 48·4	84 2·9	94 38·4	89 15·1	74 4·5	102 54·7	78 28	98 45·6	88 33·2	88 54·15	
April 13.	.....	83 38·5	94 47	82 47·6	95 14·9	89 7	75 36·9	101 13	78 53	98 23·6	88 31·62	88 49·31	
15.	.....	83 5·5	95 22·5	82 30·9	96 27·2	89 21·52	78 21	98 23·3	75 45·4	101 46·7	88 34·12	88 57·82	